

# Student Workbook

California Education and the Environment Initiative

# B

Biology Standard  
B.6.a.



# Biodiversity: The Keystone to Life on Earth

## California Education and the Environment Initiative

Approved by the California State Board of Education, 2010

### The Education and the Environment Curriculum is a cooperative endeavor of the following entities:

California Environmental Protection Agency

California Natural Resources Agency

Office of the Secretary of Education

California State Board of Education

California Department of Education

California Integrated Waste Management Board

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**Biodiversity (biological diversity):** A measure of the number of different species of organisms in a specific area, also used as a general description of species richness, ecosystem complexity, and genetic variation.

**Biome:** Large regions of Earth's surface that share similar characteristics of climate and vegetation.

**Bioregion:** A large area of land or water containing a geographically distinct collection of natural communities.

**Byproduct:** Something, such as waste materials or chemicals, produced when something else is manufactured or consumed.

**Carbon footprint:** The total amount of carbon gases produced directly and indirectly through human activities that use carbon-based fuels.

**Clear-cutting:** A method of logging that involves cutting down entire sections of a forest. (*Note: In California these areas are on average 20 acres and no larger than 40 acres. By law, they must be replanted with trees after harvest.*)

**Conservation:** The management, protection, and use of resources and natural systems in a way that can meet current and future needs.

**Conservation easement:** A legal agreement between a landowner and government or land trust, that places development restrictions on a tract of land for conservation purposes.

**Consumption:** The act or process of obtaining and using a product or resource, whether produced by a natural system or a human social system.

**Ecosystem:** A specific area, such as a kelp forest, that contains a characteristic set of interdependent species that interact with each other and the abiotic components found there.

**Ecosystem goods:** Tangible materials, such as timber and food, produced by natural systems, that are essential to human life, economies, and cultures.

**Ecosystem services:** The functions and processes that occur in natural systems, such as pollination, that support or produce ecosystem goods and help sustain human life, economies, and cultures.

**Endemic species:** A species that is present in and limited to a particular region.

**Genetic diversity:** A measure of the variation in the genetic makeup of organisms in a particular species.

**Invasive species:** A species that is introduced to an area beyond its normal range, where it spreads rapidly and crowds out native species.

**Keystone species:** A species whose loss from an ecosystem would cause a substantial change in other species' populations or ecosystem processes and whose continued well-being is vital for the functioning of the ecosystem as a whole.

**Population:** The number of individuals of one or more species living in a place at a given time.

**Preservation:** Protection of undisturbed natural resources by setting them aside and restricting human use.

**Rarity:** A measure of the scarcity of a species resulting from a small population or limited distribution.

## Key Unit Vocabulary

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**Rarity hotspots:** Areas with many species with limited distribution, or low population levels, that face immediate threat, making them a high priority for conservation efforts.

**Species:** Genetically related organisms that resemble one another and can successfully reproduce.

**Species of concern:** An informal designation used by state and federal resource management agencies for species for which there are some concerns regarding status and threats, but for which there is insufficient information available to indicate a need to list the species under the Endangered Species Act.

**Species richness:** A measure of biodiversity, indicating the total number of taxa in a given area.

**Taxa:** The name applied to groups of organisms at various levels of biological classification, such as genus, species, and subspecies.

## Bioregion Study Guide

Lesson 1 | page 1 of 2

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Name: \_\_\_\_\_

**Instructions:** Complete the following tasks in the spaces provided.

1. What is a bioregion? (1 point)

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2. What is the name of the bioregion in which you live? (1 point)

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3. How would you define “biodiversity”? (2 points)

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4. Name one type of ecosystem characteristic of your bioregion. (1 point)

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5. Name two types of producers living in your bioregion. (2 points)

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**Bioregion Study Guide**

Lesson 1 | page 2 of 2

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Name: \_\_\_\_\_

6. Name two types of consumers living in your bioregion. (2 points)

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7. Name one rare, threatened, or endangered species found in your bioregion. (1 point)

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8. What is one way in which humans in your bioregion make a living that is directly connected to the natural systems? Explain why or how. (2 points)

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9. How can knowing about the biodiversity of a bioregion help state and local agencies protect that biodiversity? (2 points)

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## Questions About the Benefits of Ecosystem Goods and Ecosystem Services

Lesson 2 | page 1 of 4

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Name: \_\_\_\_\_

**Instructions:** Read the assigned section **Benefits of Ecosystem Goods and Ecosystem Services** (Student Edition, pages 29–33). Then answer the questions related to your reading in the spaces provided.

### Protection

1. What happened in the coastal ecosystem that increased the effects of flooding from Hurricane Katrina?

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2. What factors led to the flooding in Haiti in 2004?

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3. What ecosystem service was decreased when human activities reduced the biodiversity of the coastal vegetation in Louisiana and parts of Asia and in Haiti's forests?

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### Pollination

1. What would happen to the variety of fruits and grain crops grown in the United States if the pollinators they need no longer lived in the ecosystem?

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## Questions About the Benefits of Ecosystem Goods and Ecosystem Services

Lesson 2 | page 2 of 4

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Name: \_\_\_\_\_

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2. What would happen to pollinators if an ecosystem could no longer support the plant communities that provide food, shelter, and breeding places?

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3. What ecosystem goods and ecosystem services would decrease if human activities reduced the biodiversity in orchards and farms?

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### Medicines from Nature

1. What are the natural sources of most medicines?

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## Questions About the Benefits of Ecosystem Goods and Ecosystem Services

Lesson 2 | page 3 of 4

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Name: \_\_\_\_\_

2. In what types of ecosystems are the sources of many medicines located?

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3. Why could an increase in human activities that reduces biodiversity have a larger effect on medicines from nature than we can currently predict?

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### Ocean Food Webs

1. How did the removal of one species affect the diversity of the whole ecosystem?

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2. How can the removal of one species affect the protein intake of humans worldwide?

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**Questions About the Benefits of Ecosystem Goods and Ecosystem Services**

Lesson 2 | page 4 of 4

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Name: \_\_\_\_\_

- 3. What ecosystem goods and ecosystem services would decrease if human activities reduced biodiversity in the world's oceans?

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**Genetic Diversity**

- 1. What would happen to the world's food choices if the diversity in the ecosystems that are the sources of these foods decreases?

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- 2. How is genetic diversity connected to the potential for future food sources?

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- 3. How could human activities that reduce biodiversity in the world's ecosystems affect future food sources?

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## Biodiversity and Ecosystem Goods and Ecosystem Services

Lesson 2 | page 1 of 3

Name: \_\_\_\_\_

**Instructions:** Write a three-paragraph essay describing how changes in biodiversity can affect ecosystem goods and ecosystem services provided by a natural system that benefit human communities.

Your essay should:

- define biodiversity and describe how biodiversity affects an ecosystem
- discuss one type of ecosystem goods and one type of ecosystem services described in the articles that benefit human communities
- describe how human activities that affect biodiversity also affect availability of ecosystem goods and ecosystem services to human communities

Use the **Biodiversity and Ecosystem Goods and Ecosystem Services Scoring Tool** to guide your writing. Your teacher will be using the scoring tool to score your essay.

### Biodiversity and Ecosystem Goods and Ecosystem Services Scoring Tool

| Criteria   | Points Possible |
|--|-----------------|
| <b>Content—The essay should:</b>   |                 |
| Define biodiversity and describe how biodiversity affects an ecosystem   | 4               |
| Discuss one type of ecosystem good that benefits human communities   | 4               |
| Discuss one type of ecosystem service that benefits human communities  | 4               |
| Describe how human activities that affect biodiversity also affect availability of these ecosystem goods and ecosystem services to human communities | 4               |
| <b>Writing quality—The essay should:</b>   |                 |
| Employ proper grammar, word use, punctuation, spelling   | 4               |
| Be well organized and easy to understand   | 4               |





## Land Use and Vegetation Changes Over Time

Lesson 3 | page 1 of 5

Name: \_\_\_\_\_

**Instructions:** Examine the pair of satellite images provided by your teacher. Look for differences between the two images. Then fill in the three columns for the location shown in the images. When your group has answered all three questions in the row, exchange images with another group. Your group should complete the analysis for at least two sets of images. (2 points each cell, 42 points total)

| Location                              | What type of land use or vegetation changes occurred in the region shown in these two satellite images? | How do you think that biodiversity changed in the region shown? Why? | Predict how this same type of land use or diversity change could take place in California. |
|---------------------------------------|---|--|--|
| <b>Mount St. Helens, Washington</b>   | <hr/>   | <hr/>          | <hr/>                                |
| <b>Bolivian Farms and Communities</b> | <hr/>   | <hr/>          | <hr/>                                |

**Land Use and Vegetation Changes Over Time**

Lesson 3 | page 2 of 5

Name: \_\_\_\_\_

| <b>Location</b>                 | <b>What type of land use or vegetation changes occurred in the region shown in these two satellite images?</b> | <b>How do you think that biodiversity changed in the region shown? Why?</b> | <b>Predict how this same type of land use or diversity change could take place in California.</b> |
|---------------------------------|--|---|---|
| <b>Brazilian Rainforest</b>     |  |   |   |
| <b>Agriculture in Louisiana</b> |  |   |   |





Name: \_\_\_\_\_

**Analysis Chart**

**Instructions:** Complete the following tasks in the chart below. (10 points)

1. List two causes of change that could affect biodiversity in California. One should be a human-induced change and the other a change due to natural causes.
2. For each type of change, describe the predicted effect on biodiversity and the reasoning behind this prediction.

| Type of change possibly affecting biodiversity in California                    | Predicted effect on biodiversity                | Reason for this prediction                      |
|---|---|---|
| <p><b>Caused by humans:</b></p> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> | <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> | <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> |
| 1 point   | 2 points  | 2 points  |
| <p><b>Caused by nature:</b></p> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> | <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> | <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> |
| 1 point   | 2 points  | 2 points  |

**Conservation and Preservation Notes**

Lesson 4 | page 1 of 2

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Name: \_\_\_\_\_

**Part 1**

**Instructions:** Read your group’s assigned **Case Study** (Student Edition, pages 36–40), then answer the following questions in the spaces provided.

**Case Study**

**Title of case study our group read:** \_\_\_\_\_

Groups and individuals mentioned in the case study (Who is a part of the story?):

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Time frame for the case study (When did this story take place?):

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Main idea of the case study (What is the story about?):

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How is this case study an example of conservation or preservation of natural systems?

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**Conservation and Preservation Notes**

Lesson 4 | page 2 of 2

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Name: \_\_\_\_\_

**Part 2**

**Instructions:** Select an agency/organization/group and complete the following tasks in the spaces provided.

**Researching Conservation and Preservation**

I will describe \_\_\_\_\_ (Name of local, state, or federal agency or organization involved in conserving or preserving biodiversity in natural systems)

The name and mission statement of this agency/organization/group: (5 points)

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The agency/organization/group works in \_\_\_\_\_ (location),  
with \_\_\_\_\_ (type of ecosystem/bioregion(s)). (5 points)

The agency's/organization's/group's work helps biodiversity in California's natural systems by: (10 points)

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## Implications of Losing Biodiversity

Lesson 5 | page 1 of 4

Name: \_\_\_\_\_

**Instructions:** Read the four sections below, discuss them with your group, and complete the following tasks in the spaces provided. Identify the ecosystem discussed in each section. Describe how the ecosystem could be affected by the loss of species in each example. Explain how the loss of at least one ecosystem good or ecosystem service in each example could affect human communities.

### Protection from Natural Disasters

Forests and wetlands throughout the world play critical roles in Earth's water cycle. These areas soak up rainfall, allowing water to seep into the ground. Some of the water trickles down through soil and becomes groundwater. Loss of forests and wetlands increases the amount of rainfall draining into streams immediately after a storm. More runoff can lead to downstream flooding. The chance of drought also increases because less water is stored in the ground. Preserving forests and wetlands reduces damage from floods and droughts. These natural plant communities also can help to shelter coastal communities from hurricanes, tsunamis, and extreme weather.



Healthy wetland

**Ecosystem:** \_\_\_\_\_

How could the loss of one or more species affect the ecosystem?

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How could the loss of an ecosystem good or ecosystem service affect human communities?

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Name: \_\_\_\_\_

**Medicines from Nature**

Bacteria that have become resistant to all available drugs pose a health care challenge. To overcome resistant strains of bacteria, doctors need new medicines. Soil fungi are a likely source of many new drugs.

Chemicals originally extracted from plants, animals, fungi, or microorganisms form the basis of over 40% of all prescription medicines in the United States. The source plants, animals, fungi, and microorganisms live in many different ecosystems, from forest to oceans. One example is Taxol. Taxol is a substance found in the stembark of the Pacific yew tree native to the coastal forests of the Pacific Northwest. Doctors prescribe Taxol to inhibit growth of certain types of tumors. Originally discovered in nature, Taxol is now manufactured by pharmaceutical companies.

With each species that becomes extinct, humans lose as-yet-undiscovered ways to fight



Pacific yew tree

disease. At current rates of extinction, scientists estimate Earth is losing an undiscovered major new drug every two years. This number is a rough estimate because scientists have studied only a few species for potential medical uses. For example, less than 1% of the world's 250,000 tropical plants have been screened for chemicals that might be useful in medicine.

**Ecosystem:** \_\_\_\_\_

How could the loss of a species, such as the Pacific Yew, affect the ecosystem?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

How could the loss of an ecosystem good or ecosystem service affect human communities?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Name: \_\_\_\_\_

### Ocean Food Webs

Sea otters eat sea urchins. Without sea otters, sea urchin populations increase, rapidly consuming and destroying the kelp forests in which they live. This in turn affects the many species that rely on the kelp forest ecosystem.

In 1977, federal officials placed sea otters on the Endangered Species list. With this new protection, depleted California sea otter populations began to recover. As their numbers grew, otters once again were able to keep sea urchin populations in check. Kelp forests began to rebound, and other species gradually reappeared. The sea otter is not yet out of danger of extinction. Scientists and conservationists are working to determine ways to continue protecting this species vital in maintaining healthy kelp forest ecosystems.

A similar story is unfolding in the Atlantic Ocean. There, scientists have discovered that overfishing of great sharks has led to decline in the bay scallop fishing industry. Decrease in 11 species of great sharks has affected marine food webs. The



Shark harvesting

sharks prey on such organisms as rays and skates. Decline in shark populations has led to growth of the populations of these prey organisms. One in particular, the cownose ray, is creating problems for the shellfish industry along the eastern coast of the United States. Without shark predators to keep their populations in check, these rays have become so abundant that they are wiping out the populations of scallops, oysters, and clams. The loss of sharks and otters—two keystone species—affects this multibillion-dollar seafood industry.

**Ecosystem:** \_\_\_\_\_

How could the ecosystem be affected by loss of species, such as sea otters or sharks?

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How could the loss of an ecosystem good or ecosystem service affect human communities?

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Name: \_\_\_\_\_

**Genetic Diversity**

In the wild, genetic variation is important for survival of every species in all ecosystems. Think of a species that has come close to extinction. The California condor is one example. When only a few individuals remain, genetic diversity is greatly reduced. This leaves the species with less variability and a reduced capacity to adapt to change.

If genetic diversity of important crop species drops too low, humans could face a threat to global food security. One solution is to create “gene banks.” For example, the International Potato Center preserves potato genes. The center stores samples of about 100 wild potato species. It also has 3800 varieties collected from small South American farms. Gene banks could also be established for state and national timber resources, and other tree species. Another solution is to preserve natural areas in which wild varieties grow. Maintaining healthy natural ecosystems will protect gene pools by supporting the survival of a wide range of species.



Wild potato tubers, U.S. Potato Gene Bank

**Ecosystem:** \_\_\_\_\_

How could the loss of species, due to lack of genetic diversity, affect an ecosystem?

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How could the loss of an ecosystem good or ecosystem service, resulting from lack of genetic diversity, possibly affect human communities?

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**Human Activities and Biodiversity in California**

Lesson 6 | page 1 of 3

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Name: \_\_\_\_\_

**Instructions:** Use the spaces below to take notes during the class discussion.

Byproduct:

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Consumption:

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Population Increases:

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Hotspots:

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Name: \_\_\_\_\_

“California is home to the largest population of people in the country, with the highest projected growth rates into the future. The human demands for the land, water, and natural resources that make life so abundant in California present the greatest threats to its unique plants and animals.

“California leads the nation in number of rare species within a state, and nearly one third of its species are identified as at risk in the United States.

“Our challenge is to meet the needs of society while maintaining the state’s remarkable biodiversity for future generations.”

**Source:** Atlas of the Biodiversity of California. Sacramento: California Department of Fish and Game, 2002 p. 2.

**Instructions:** Think about the quotes above and what you have learned in this lesson. In one or two paragraphs, answer the following questions in the spaces provided. Use the vocabulary words and information from your notes in your responses. Use the **Human Activities and Biodiversity in California Scoring Tool** on the next page to guide your writing.

1. What makes California special in terms of biodiversity? (12 points)

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2. What challenges and opportunities does this biodiversity present in terms of the state’s future land use and natural resources management? (12 points)

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## Human Activities and Biodiversity in California

Lesson 6 | page 3 of 3

Name: \_\_\_\_\_

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### Human Activities and Biodiversity in California Scoring Tool

| Component  | 3 points  | 2 points   | 1 point   |
|--|---|--|---|
| <b>Importance of Biodiversity</b>                    | Identifies that California is a biological “hotspot” for the world because of its high level of biodiversity.   | Identifies that California has many bioregions/a high level of biodiversity.   | Mentions biodiversity or rarity hotspots.   |
| <b>Influence of Human Activities on Biodiversity</b> | Identifies that population rates and consumption are related and affect biodiversity.   | Identifies that population rates or consumption affect biodiversity.   | Mentions population, consumption, or their effect on biodiversity.  |
| <b>Future Changes</b>                                | Discusses that population consumption levels will rise in the future and mentions byproducts of consumption.  | Discusses that population and consumption levels will rise in the future but does not mention byproducts of consumption.                                     | Identifies but does not discuss future population and consumption predictions.  |
| <b>Challenges and Opportunities</b>                  | Discusses biodiversity challenges and opportunities and what human communities in the state should and should not do in terms of the biodiversity hotspots. | Identifies biodiversity challenges and opportunities and what human communities in the state should and should not do in terms of the biodiversity hotspots. | Identifies a biodiversity challenge or opportunity, but does not discuss what human communities in the state should or should not do in terms of the biodiversity hotspots. |







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## California Education and the Environment Initiative